

URANIUM ORES IN THE FREIBERG DISTRICT OF THE REGIONAL MINING AUTHORITYA) Pitchblende ores:1) Johanngeorgenstadt:

There are individual veins of uranium pitchblende in the eastern part of the mine field in the Frisch Glück section of the Vereinigt Feld mine at Fastenberge in Johanngeorgenstadt. Uranium pitchblende was discovered at the Georg Wagsfort Spat, the Segen Gottes Spat, and the Neugeboren Kindlein Fläche. Up to 1920, 20.2 tons of uranium ore, corresponding to approximately 1.4 tons of uranium, were mined at the Segen Gottes Spat.

In the year 1936/37, for purposes of investigating these veins at the 78 lachter level (NOTE: 1 Saxon lachter equals 2 meters), a transverse was drilled along the pitchblende veins, passing the Georg Wagsfort Spat and the Neugeboren Kindlein Fläche. In 1938, the Neugeboren Kindlein Fläche was worked further to the east and west. In the east, the vein lost its extraordinarily variable ore-content after about thirty meters. There were ore traces for about fifty meters to the west. In 1939, the Georg Wagsfort Spat was investigated for a short distance to the east and west. An ore-pocket was excavated downward for a distance of four meters and, likewise, in 1939, a relatively rich ore-pocket was excavated upwards for about nine meters. These diggings uncovered about thirty square meters of vein surface and yielded about 250 kilograms of ore containing approximately 38.9 kilograms of U_3O_8 . The veins, therefore, had an average content of 1.3 kilograms of U_3O_8 per square meter exposed. The method of mining resulted in considerable wastage, so that the actual uranium content of the ores encountered at those spots must have been considerably higher. Most of the veins were 1-2 centimeters thick, with a maximum thickness of 10 centimeters. The

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pitchblende there occurred without gangue, much as at the apophysis of the Glückauf Vein in St. Joachimsthal. Gangue, when it did occur, was quartziferous.

Because of the vein thickness of these slightly worked, pronouncedly ore-rich pockets, the average U_3O_8 content amounted to 2.6 percent; the U_3O_8 content of a vein of minable width (including country rock) ran in the neighborhood of 0.2 percent.

Since the mine received subsidies from the Reich only for its bismuth production, it became necessary to discontinue investigation of the uranium.

Some figures from St. Joachimsthal are herewith given for purposes of comparison:

The Schweizer Vein in recent years has yielded 1.1 kilograms of U_3O_8 per square meter in the exploited area. Figured on the basis of the total thickness of the vein, including the many intercalations of schist of the vein as a whole, the entire vein mass gives a yield of 0.04 percent U_3O_8 .

The Bergkittler Vein has yielded 1.2 kilograms of U_3O_8 per square meter and the vein mass as a whole has a U_3O_8 content of 0.5 percent.

The Geister Vein has yielded 0.6 kilograms of U_3O_8 per square meter; the average U_3O_8 content of its pure ore is 0.1 percent.

The other part of the mine, including the country rock in Johanngeorgenstadt, yields no uranium.

2) Schneeberg:

Despite the high emanation content of the air from the mine, uranium ores occur only very rarely at Schneeberg. The country rock of the bismuth veins is likewise practically free of uranium.

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3) Margarete bei Breitenbrunn:

There, a magnetite-bearing skarn deposit is traversed by vein conglomerate of the Bi-Co-Ni formation. Within the magnetite-bearing skarn, uranium pitchblendes occur occasionally as mineralogical anomalies.

4) Others:

Uranium pitchblendes have also been found as mineralogical anomalies in the Himmelsfürst and Himmelfahrt mines in Freiberg. The same is true of the Himmlisch Heer mine near Annaberg.

B. Autunite and torbernite ores:

At the Himmelfahrt mine on the Milchsachsen near Steinbach near Johanngeorgenstadt, autunite ores occur at a side apophysis (a vein of oxydic bismuth ores) of the Michael Spat. There are several tons of matter with a U_3O_8 content of about 0.5 - 1 percent. Nonetheless, the deposit is practically without importance, for it is too small, as the mining of bismuth has shown.

Freiberg/Saxony, 15 September 1945

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URANIUM-BEARING DEPOSITS IN THE ERZGEBIRGE

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I. URANIUM MINING AT ST. JOACHIMSTHAL:A. Vein Conditions:

The St. Joachimsthal region consists, for the most part, of heavily plicated micaceous schist, trending in an east-west direction along the rather narrow Joachim Valley. According to Krauss, these crystalline schists, which trend in an east-west direction in the Joachimsthal area, assume a north-south direction just south of Gottesgab, in the Erzgebirge range.

The Karlsbad-Eibenstock granite massif outcrops in the western part of this area. As a result of the extrusion of granite magma, extrusive veins of rather ancient origin, quartz porphyres and lamprophyres, pervade the area. The resumption of volcanic activity in the Tertiary Period caused basalt veins and basalt-and-phonolite lava plugs to appear in the more outlying areas of the mineralized zone. Geognostically, the area is decisively influenced by two belts of deformation, formed in very early times and modified over the course of various geological epochs. This condition obtains in the southern portion of the Erzgebirge Fault, the formation of which is older than the intrusion of the stanniferous granite (Zinngranit), as the coarse-grained structure of the tin-ore veins clearly shows. Krauss, in "The National Uranium Pitchblende Mining District of St. Joachimsthal", [Das staatliche Uranpocherzrevier von St. Joachimsthal], Vienna, 1916, arrived at the same conclusion. The second deformation affecting the tectonic picture is the Zeileisengrund Deformation, which, likewise of very ancient origin, was formed in a north-south direction, trending northwards across the Erzgebirge range. Other tectonic lines, namely the Hercynian trend of the boundary fault of the Johanngeorgenstadt-Platten graben, formed at the granite - mica-schist boundary (which was caused partially by a fault, which was later filled in by a vein from the iron-manganese formation) and along the general trend of the porphyry veins running parallel to it.

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The country rock of the Joachimsthal veins west of the Zeileisengrund Deformation is a graphite-rich, micaceous schist bearing some feldspar (Joachimsthal schist). To the east of the Zeileisengrund Deformation the country rock consists of somewhat coarser gneiss - mica-schist with gritty intercalations.

There are essentially two fissure systems in these rocks. One runs approximately in an east-west direction and parallels along its course the marginal fault of the Erzgebirge between Oberbrand and Tiefenbach. The other runs in a north-south direction, roughly paralleling the Zeileisengrund Deformation. The older fissure system is the east-west one, that of the so-called "Morning Veins". For the most part, these Morning Veins are barren, occasionally filled in with leader stone and quartz. Only at the intersection with the second fissure system, the so-called "Midnight Veins", at the upper levels, have ores been discovered.

Concordant, high-contact metamorphs and, to some extent at Erlanfels, metamorphic limestone are intercalated here and there in the Joachimsthal schist.

In the upper levels, the Midnight Veins mineralogically bear mostly silver ores -- silver in the native state, argentite, a lustrous red silver ore partly in pyrites-bearing strata, and oxides at outcroppings. Beneath these silver zones, there appear at many veins not independently developed cobalt-bismuth zones, which finally are bounded by still deeper uranium pitchblende zones. At the 12th level of the Schweizer Vein there suddenly appear again, beyond a 200 meter thick, crushed, and ore-free zone of the vein, rich cobalt-nickel-bismuth ores, which in 1944 led to the resumption of nickel-cobalt-bismuth production. These ores consist essentially of bismuth in its free state, intergrown with minerals of the rammelsbergite-safflorite group. In these ores nickel predominates over cobalt.

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The silver content is low. The ores of the rammelsbergite-safflorite group are interspersed throughout with grains of bismuth, which have been partially metamorphosed into bismuthinite. These ores are extracted mostly as pure ore containing approximately 15 percent bismuth, 4 percent nickel, 3 percent cobalt, and 60 grams of silver per ton of ore.

In the veins the uranium pitchblende occurs intergrown with Bi-Co-Ni minerals, and where these minerals die out, the main ore -- pure bismuth, smaltite, and minerals of the rammelsbergite-safflorite group -- is found. Sometimes the main ore is contaminated by pyrites and galena. The question of whether the galena intergrown with pitchblende is a uranium lead sulphide has not yet been investigated. The gangue is both quartziferous and spathic. The bulk of the gangue is formed by dolomite, which assumes a reddish hue in the proximity of the uranium ores. It is striking that in the western part of the mine the uranium zone is situated at a considerably higher level than it is in the eastern part of the mine. This, however, is readily explainable when one realizes that the presence of uranium ore as a primary level is essentially dependent upon the conditions of temperature and pressure at the vein fissure. The occurrence of pitchblende must, therefore, run approximately parallel with an isothermal surface, arising from the loss of heat of the intruded granite boss; in other words, the occurrence of pitchblende roughly must follow the contours of the granite batholith. This is confirmed by the opening of new veins below the surface of the earth. In the western mine, only slightly west of the Werner Shaft, the granite was encountered at a depth of approximately 670 meters. In the vicinity of the Einigkeit Shaft, on the other hand, the batholith has not yet been contacted, despite probing to the same depth.

The same conditions obtain in the area of the Edelleutstollen Adit, east of the Zeileisengrund. The batholith appears there,

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raised by the Zeileisengrund Deformation, exactly as does the granite at the 5th level of the Edelleutstolln Adit, the pitch of which is toward the east. Further to the east, at the Franziski Vein, the granite has not yet been encountered at the 8th level.

Nothing is known about the presence of uranium pitchblende ores in the granite, as so far no veins have been traced into the granite. In St. Joachimsthal the prejudiced and completely unfounded notion prevails that the veins of the Bi-Co-Ni formation must fizzle out in the granite. This idea also prevails in Schneeberg, even in the textbooks on deposits by Back and Schneiderhöhn, although the Schneeberg area offers the most positive proof of the erroneousness of this idea. This idea arose from the fact that in Schneeberg individual veins die out before reaching the granite. In Schneeberg this may be explained by the fact that the schist forms a very steep, relatively narrowly bounded pocket in the granite. This pocket, which is minute compared to the total mass of the granite, effects a very minor indentation in the isothermal surface around the granite. Thus, the veins there die out in the schist, while at other places, veins with a very high ore-content penetrate into the granite. As to the bearing of uranium ores, it must be said that the uranium ores at the richest vein in Schneeberg, the Katharina Flache, are mostly mined from the granite. Therefore, there is absolutely no reason for adhering to the aforementioned, biased idea that veins must become barren in the granite. That some veins once in a while should peter out in the granite is obvious. However, that has nothing to do with the granite as country rock, but only with the genetic depth of the deposit.

Even though I explained these facts to the mining authorities again, they stopped pushing the transverse at the 12th level of the Joachim Shaft, which was to connect the Geister Vein at this level. Likewise, at the fifth level of the Edelleutstolln Shaft, a promising

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apophysis (filled with reddish dolomite) running into the granite was not followed beyond the granite, although this very offshoot a slight distance back had displayed small pockets of pitchblende (Glückauf Vein).

The uranium content at the vein surface itself is extremely irregular. It is not possible in the St. Joachimsthal, as usually is the case, even in the mining of precious metals, to assay a sample and on that basis to estimate the ore reserves. Since the pitchblende is never finely distributed throughout the vein, but always occurs in visible lumps, the practice in St. Joachimsthal has been to dispense with assays and to work those portions of the vein that look promising, in which case it may very well happen that the mining effort is being made in an area completely devoid of ore. Thus, it was my experience on an inspection tour of the mine in the summer of 1939 to see uranium pitchblende ore at only spot that was being worked. Everywhere else the vein was completely barren. It sometimes happens that a spot will be worked for months before any ore is struck, and then within a short period as much ore will be extracted as would normally be expected within a year's time.

This extreme variability of ore-bearing renders assaying completely worthless. Because of this variability of ore-content, the mining modus operandi is somewhat different from ordinary. Whenever possible, the country rock is blasted first, and then the vein; if the latter bears pitchblende, all massive ores and all barren chunks of rock are carefully sorted out from the blasted debris. The waste is removed and the surplus transported to the surface. The massive ores are packed in closable buckets and transported in these to the surface. The heavily intergrown pieces and the smalls caused by the blasting are transported separately. In this way an average yield of 7 percent U_3O_8 is obtained from all the ore. The matter of whether it might not be purposeful to process all the vein material in order

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to avoid losses and, as is the case in the mining of tin ores, to process ores with a content of less than one percent, has not yet been investigated. It is also very important to investigate this matter from the pulverization-technical viewpoint, as the uranium ore is very brittle and thus is inclined to form very tiny grains, which wash away in the processing treatment, resulting in considerable losses.

The only way to evaluate the veins and to determine the reserve figures is to tabulate the average figures on the mining potential coefficients and the waste of each of the veins and their further exploitation within sensible limits.

B. Production:

The following survey indicates the production of uranium ores from 1929 to 1944:

<u>year</u>	<u>tons of U₃O₈</u>	<u>grams of radium</u>
prior to 1929		28,210
1929	14	3.512
1930	11.4	3.578
1931	11.3	3.7
1932	13.3	3.75
1933	11.7	3.28
1934	9.8	2.75
1935	8.9	2.5 (estimated)
1936	14.8	4.125
1937	5.4	1.5 (estimated)
1938	5.4	2.5 (estimated)
1939	4.78	1.338
1940	5.918	1.656
1941	5.532	1.826
1942	9.5	2.662
1943	10.5	2.915
1944	11.6	3.255
		<hr/> 72.057

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Furthermore, in 1944 5.988 tons of bismuth, 0.95 tons of cobalt, and 1.11 tons of nickel (expressed as metal) were sold as concentrate.

The figures up to 1936 were obtained from Part I of the study "Mineral Raw Materials" [Heft I, "Die Mineralischen Rohstoffe"] by Krusch. The figures for 1935, 1937, and 1938 are estimates. The figures from 1939 to 1944 have been obtained from the statistics of the Regional Mining Authority.

The visible and apparent reserves as of 1 January 1945 are estimated as follows:

<u>vein</u>	<u>tons of U₃O₈</u>
Schweizer Vein	29.3
Bergkittler Vein	15.6
Glückauf Vein	1.8
Zeidler Franziski Vein	8.2
Total	54.9 tons with 15.36 gr of radium.

The possible ore-reserves, the breakdown of which is shown in the appended table, are estimated at 241 tons of U₃O₈, so that the total ore reserve to a depth of 900 meters is approximately 296 tons of U₃O₈ with 82.8 grams of radium.

The determination of the reserves of possible ores has been made down to the 900 meter level only. That does not preclude, however, the possibility that veins of the eastern mine around the Einigkeit Shaft may bear ore at still lower levels.

C. Great depths heretofore attained:

The opening up and investigation of new veins so far has been conducted only a few meters below the 12th level of the Joachim Shaft, 670 meters beneath the slope of the Werner Shaft. Mining operations themselves at the individual veins, for the most part, have not reached such depths. Only the veins of the eastern mine around the Einigkeit Shaft, the Häuerzecher Vein, and the Geschieber

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Vein may, in practice, be considered as being worked as far as the 12th level. The greatest depth of the other veins, with respect to the slope of the Werner Shaft, is indicated in Column 14 of the appended table.

D. Further possibilities of new openings:

There are further possibilities in St. Joachimsthal worth investigating, but these investigations must be carried out in the depths as well as ~~well as~~ along the strike. Of the many possibilities, the following have been proposed:

1) Investigations along the strike:

a. Schweizer Vein:

The digging of drifts at the third or fourth level above the Kùhgang to the north and the Geier Vein to the south.

Up to now the Schweizer Vein has been investigated only between these two "morning veins", as the unprovable idea prevails that the vein bears ore only between these two east-west veins. From the viewpoint of the geology of deposits, however, there is no basis for this assumption, particularly since uranium-ore bearing veins are known at another spot (Roter Gang) north of the Kùhgang. The other drifts planned by the mining authorities are, naturally, to be continued.

Other trending drifts at the 12th level.

Continuation of the trending drifts already begun at other levels.

b. Bergkittler Vein:

Investigation in the same manner as at the Schweizer Vein.

c. Geister Vein:

Further trending drifts at the 6th level, overhead mining operations and tunnels therefrom.

d. Glückauf Vein:

Continuation of the trending drifts, even through granite, at the 5th and 8th levels.

e. Zeidler Franziski Vein:

More extensive exploitation at the 8th and 10th levels and at the intermediate level between the 5th and 8th levels.

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As in many areas these veins are inclined to split up into a multitude of tiny veins, the overlying beds and the underlying beds should be investigated by the sinking of transverses at regular intervals at deposits showing signs of splitting up. This is a measure which has been carried out all too infrequently at St. Joachimsthal.

2) Downward investigations:

a. Continuation of the transverse to the Geister Vein at the 12th level and the exploitation of the Geister Vein at the 12th level.

b. Investigation of the Schweizer Vein and of the Bergkittler Vein below the 12th level by means of a vertical probe.

c. Investigation of the veins of the eastern mine by means of a blind shaft at the lower level between the Häuenzecher and Johannes Evangelisten Veins.

d. To drive right under the Fundgrübnr, Prokopi, and Kaiser Franz-Josef Veins by means of a long easterly traverse at the 12th level.

Freiberg/Saxony, 5 October 1945
OWO/S

signed Dr. Oelsner

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2d POSSIBLE OR RESERVE OF S. JALSHIVETAL

Anticline 4: 4.5%	Average pitch (App. in degrees)	Average length	Average no. of clips kg/m ² U ₂ U ₃	Level of which there is complete exploitation in meters	Reserve level: vertical in meters	Vertical depth in meters	Estimated inclination (deg/m ²)	Estimated coeffi- cient of exploita- tion m ²	Possible ore yield (kg/m ²)	Possible reserve of U ₂ U ₃ (kg)
1	2	3	4	5	6	7	8	9	10	11
1.17%	70	0.90	40	18	46	53	12	0.6	0.7	30
1.06%	80	0.85	80	14	46	67	29		0.75 I	5,400
1.36%	50	0.85	40	17	46	90	22		0.5 I	21,900
—	70	0.40	40	—	—	90	22		0.5 I	35,900
—	80	0.90	40	—	—	90	22		0.5 I	10,400
—	80	0.90	40	—	—	90	22		0.5 I	20,800
1.20%	80	0.95	50	18	99	90	22	0.5 Gut. 0.587	0.3	21,000
—	80	0.90	20	—	—	2nd Joachim level, 67	8	0.6	0.25	22,400
—	80	1	20	—	—	90	39	0.5	0.3	2,500
1.30%	80	0.85	30	9	18	2nd Joachim level, 67	20			14,600
1.50%	70	0.40	30	30	46	90	39			19,800
—	70	0.85	10	—	—	1st level 58	15	0.5	0.3	54,600
										1,600
										241,000 kg U ₂ U ₃

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the gravity slope

THE POSSIBLE ORE RESERVES OF ST. JOACHIMSTEAL

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Metal content in U_3O_8 = 0.07081 (in kg)	Incidence of U_3O_8 kg/m^2	Average pitch (dip) in degrees	Average length	Average ore density kg/m^3	Level to which there is complete exploitation, in meters	*Reserves lower limit Vertical (meters) / sic /	Vertical depth attained (meters)	Estimated incidence (kg/m^2)	Estimated coefficient of exploitation with	Possible ore yield (kg/m^2)	Possible reserves of U_3O_8 (kg)		
8	9	10	11	12	13	14	15	16	17	18	19	20	21
---	---	70	0.94	250	---	---	---	Werner Level 530	120	0.6	0.2	32	3,800
10,100	1.175	70	0.94	400	184	469	Omitted in photostating	Joachim Level 674	205	---	---	0.25 Σ 46	9,400
19,500	1.065	80	0.985	400	194	469		900 m	226	---	---	0.5 Σ 97	21,900
59,300	1.252	55	0.819	600	176	469		900 m	226	---	---	0.5 Σ 159	35,900
---	---	70	0.94	400	---	---		---	226	---	---	0.25 Σ 46	10,400
---	---	85	0.996	400	---	---		900 m	226	---	---	0.5 Σ 92	20,800
---	---	85	0.996	600	---	---		900 m	226	0.5 Est. 0.587	0.3	106	24,000
6,490	1.705	80	0.985	500	198	592		900 m	226	---	---	0.5 Σ 99	22,400
---	---	85	0.996	200	---	---		2nd Joachim Level, 674	82	0.6	0.25	30	2,500
---	---	90	1	250	---	---		900 m	390	0.5	0.3	37.5	14,600
21,000	1.595	60	0.866	300	94	383		2nd Joachim Level, 674	204	---	---	94	19,200
42,300	3.55	70	0.94	300	304	469		900 m	399	---	---	0.5 Σ 152	54,600
---	---	75	0.966	100	---	---		1st Level 541	157	0.5	0.2	20	1,600
											241,000 kg U_3O_8		

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THE POSSIBLE ORE RESERVES OF ST. JOACHIMSTHAL

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I. Calculation of the average ore density from the mine yield so far

Name of the vein	Calculation of the average ore density is based on the completely exploited vein portions between the following levels	Total vein surface worked (for 2) 2 m	Vein surface worth exploiting 2 m	Vein surface worth exploiting for which extraction is planned 2 m	Coefficient of exploitation worth	Crude ore extraction (tons)	Total content in U.S. = 0.07081 (in kg)
1	2	3	4	5	6	7	8
(1) Roter (Red) Vein		—	—	—	—	—	—
(2) Geister Vein	4th Werner Level — above the Barbarastollen.	46,200	17,000	8,600	0.368	142,381	10,100
(3) Bergkittler Vein	4th Werner Level — 1st Werner Level.	40,600	18,325	18,325	0.45	375,499	19,500
(4) Schweizer Vein	4th Werner Level — above the Danielstollen.	101,720	52,987	47,390	0.52	837,913	99,300
(5) Johannes Heugelin Vein		—	—	—	—	—	—
(6) Hauersecker Vein		—	—	—	—	—	—
(7) Goschleber Vein		—	—	—	—	—	—
(8) Hildebrandt Vein	5th Joachim Level — floor of adit.	37,140	8,500	3,800	0.229	91,558	6,490
(9) Prekopi Vein		—	—	—	—	—	—
(10) Kaiser Franz-Josef Vein		—	—	—	—	—	—
(11) Stiehmuf Vein	3rd Level — floor of adit.	78,100	13,170	13,170	0.1685	296,215	21,000
(12) Franziska Seidler Vein	5th Level — floor of adit.	60,949	16,225	11,900	0.268	597,640	42,300
(13) Milfe Gottes Vein		—	—	—	—	—	—

(The dashes in the various columns mean that there are no accurate figures available. "E Gt" stands for the ore-density of the Geister Vein. "Gt" stands for the pitch (dip) of the Geister Vein. All of the depth figures are referred to the depth below the grassy slope

(at the Werner Shaft (= +933 meters).

* Heading 16 partially omitted in photostating.

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II. THE MINING OF BISMUTH AT JOHANNGEORGENSTADT, WITH PARTICULAR ATTENTION TO THE MINING OF URANIUM

A. Vein conditions:

The Johanngeorgenstadt area represents a pit-like depression, formed by two rather large faults, in the marginal area of the Ribanstock Granite. Parts of the schist mountains overlying the granite along the periphery are contained within the depression. In the vicinity of Johanngeorgenstadt, at the surface of the earth, there occur phyllites and products thereof, maculose schist, knotted schist, fruchtschiefer, etc, caused by contact metamorphism; in the most highly metamorphosed spots there occur andalusite schists and hornblendites. As mining operations have shown, this complex of schists is underlain by granite. There are fault systems of various ages in the granite. The oldest of these fault systems, judging from the formation of the vein fissures, are about the same age as the peripheral fault of this depression. They are older than the known ore veins in the Johanngeorgenstadt area. They have been formed from very thick zones of completely jumbled (zerruschelt) rock, the so-called "crumbles" (Fäule). Ores having their origin in the hypothermal-mesothermal metamorphism of the granite are not found in the "crumbles". These "crumble" zones, which here and there bear thin deposits of the epithermal and magma-distant veins of the iron-manganese ore formation, which in the rather narrow Johanngeorgenstadt area have never been the object of mining for any appreciable period of time. On the other hand, from time to time the hematite from similar veins at the marginal fissures of the Johanngeorgenstadt depression has been mined zealously. In the south-eastern part of the depression, these fissures trend in a northwest-southeast direction. In the northwestern part of the depression, they bend into north-northeast ^{west} -- south-southeast direction. The ^{actual} ~~real~~ bismuth ore veins are the veins with east-west, northwest-southeast,

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and northeast-southwest trends; they are more recent than the "crumbles", die out on encountering the "crumbles", and then, to some extent, reappear on the other side in a minable condition.

The vein fissures of the Johanngeorgenstadt area are peculiar in that they, after their first appearance, are quite frequently ruptured and cross-penetrated. Thus it is that completely different mineral parageneses may occur at similar veins. The first vein filling was of a pneumatolytic nature and consisted of parageneses of the tinstone formation, mostly cassiterite and quartz. These veins bear cassiterite only in the upper levels and, when mining was first begun, provided the basis for a modest production. In the lower levels there is only pneumatolytic quartz, the so-called "wild quartz", which often accompanies the bismuth-bearing veins.

Hypothermal, gravelly formations of lead ore, with galena, zineblende, and pyrites, make their appearance as the next formation at the ruptured vein fissures.

In the fissure system, the mesothermal deposits of the Ni-Co-Bi formation, which bear predominantly bismuth in its natural state and (very rarely) ores of the rammelsbergite-safflorite group and, in the upper levels, free silver, argentite, and red silver ore, are of the most widespread occurrence.

Uranium ores occur at the various veins of the Johanngeorgenstadt area, and some of them are mined systematically. The mining of uranium in Johanngeorgenstadt began in 1827 and was discontinued in 1828. It was initiated again in 1839 and was continued without interruption until 1873. After a cessation of operations until 1887, mining was again taken up until 1913. In 1938, in connection with research work with the pitchblende, a small quantity was mined for the last time. Although the Erzengel Flache is known to bear uranium ore very sporadically, uranium ore has never ~~actually~~ been mined in this mining area. In the eastern part of the mining field, in the Frisch Glück Section,

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uranium pitchblende occurs at times in some veins in quantities worth mining. The mining of pitchblende has been conducted particularly at the Segen Gottes Spat, the Neugeboren Kindlein Flache, and the Georg Wagsfort Spat.

Up to 1920, according to an entry in the records of the Mining Authority, 20.2 tons of uranium ore with a content of 1.4 tons of U_3O_8 were extracted from the Segen Gottes Spat. This corresponds to a U_3O_8 content of only 7 percent. The assaying of samples of Johanngeorgenstadt ore, however, indicates the average U_3O_8 content there to be considerably higher. From 1827 on, about 30 tons of uranium ore with a U_3O_8 content of about 6 tons were mined from Johanngeorgenstadt. This corresponds to a U_3O_8 content of the ore of about 20.5 percent.

In 1936-1937, for the purpose of investigating the veins at the 78 lachter level, a transverse shaft ^{was dug} crossing the Neugeboren Kindlein Flache and the Georg Wagsfort Spat about 156 meters below the spots mined for pitchblende prior to that time. ~~was dug~~. The former was extended in 1938 to the east and west. In the east, the vein no longer bore ore, which everywhere had been extremely variable in its occurrence, after about 30 meters. In the west, the vein showed traces of pitchblende for about 50 meters. The latter (Georg Wagsfort Spat) was investigated the following year for only a short distance. An ore pocket was excavated to a depth of ⁴~~200~~ meters and, likewise, a 9 meter high ^{stop}~~hallow~~ was dug out of the drift ceiling at the Neugeboren Kindlein Flache in 1939. These diggings exposed about 30 square meters of vein surface, from which 250 ^{kilograms}~~grams~~ of pure ore were extracted. The U_3O_8 content of this ore amounted to 38.9 kilograms. In the exploited portions of the vein, therefore, the average incidence of U_3O_8 was 1.3 kilograms per square meter of surface. Considerable losses resulted from the method of mining employed, so that the actual incidence of uranium at these spots must have been

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a good deal higher. It probably corresponds to the incidence displayed by the central Joachimsthal veins.

The thickness of these veins is 1-2 centimeters, reaching a maximum of 10 centimeters. There the pitchblende occurs mostly without gangue, just as at the apophyses of the Olloksauf Vein in St. Joachimsthal. When gangue does occur, it is quartziferous and spathic (brown spar). Because of the thickness of these slightly exploited vein segments, these pronouncedly rich ore-pockets, the average U_3O_8 content amounts to 2.6 percent. The U_3O_8 content of a vein of minable width, including country rock, is about 0.2 percent.

At the same time, the Segen Gottes Spat was investigated for about 200 meters at the 93 lachter level. The vein proved to be completely barren.

As the mine received subsidies from the Reich only for its bismuth production, the investigation of uranium had to be terminated before any conclusions could be reached. The investigations, at best, are insufficient for basic research. For one thing, the distance between levels (158 meters and 184 meters) is too great in view of the expected extreme variability in the incidence of ore; then, too, the horizontal probes were too short, and intermittent investigations are almost completely lacking. On the basis of the investigations conducted heretofore, therefore, one dare not conclude that the Johanngeorgenstadt veins, with respect to their uranium content, are of no interest whatsoever.

Assuming, ^{at} the promising segments of the three veins extent a total of 600 meters and assuming a coefficient of mining worth of 0.05, the quantity of U_3O_8 at these veins may be estimated at 80-90 tons. The great variability in ore occurrence will make production costs high.

Later movement at these fissures, presumably in connection with the deformation of the southern edge of the Erzgebirge during the Tertiary Period, crushed and mixed up the vein infilling material

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considerably. Consequently, the vein fissures often occur as fault fissures, the fault nature of which is of especial significance in granite-schist contact, in that at one salband a contact schist is formed, at another, granite.

A change in the ore-content of the veins in the granite is nowhere to be observed. The ores in the granite are every bit as rich as those in its schist hull.

The Himmelfahrt Section on the Milchsachsen near Steinbach offers the best example of this. The mine is situated in the extreme west of the Johannegeorgenstadt ore region, right in the middle of the granite. At a 60 meter long, composite junction of two different veins (Schaarkreuz) there appear two apophyses bearing mineral parageneses of the pneumatolytic tin formation at the outcropping; this is a rich bismuth ocher ore-shoot. This ore-shoot -- except at the composite junction, the two apophyses are not worth exploiting -- has been traced about 150 meters below the outcropping and at the present time has been mined to the low-grade, residual remnants. All in all, it has delivered about 60 tons of bismuth.

Below this ore-shoot, the vein itself is still clearly defined. However, it bears only quartz and occasional traces of ore in unminable quantities. The roots of this small deposit, which are too poor to be worth mining, have already been exposed.

In addition to the pitchblende deposit, uranium ores in the form of torbernite are also known at the Himmelfahrt Section on the Milchsachsen near Steinbach, in the westernmost part of the mining region.

There, there appears a side apophysis (Nebentrum) of the ore-vein called the "Michael Spat". This has been exposed in the course of mining operations and, here and there, as does the main apophysis, it displays pockets of very beautiful autunite ore. Unfortunately, this deposit has proven to be purely local and rather limited in extent.

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The presence of the pockets is to be explained by the oxidation of occasional pockets of pitchblende in the primary vein filling material; the bismuth ores, too, in this area are entirely oxidic. A total of several tons of autunite ore with a U_3O_8 content of 0.5 - 1 percent and quartziferous gangue were extracted, sorted, and thrown on the mine dump. The Saxon Ore Mining Corporation (Sachsenenerz Bergwerks-A.G.), in connection with the proposed opening of the torbernite deposit at Schönficht in the Kaiserwald, conducted flotation experiments with this material, but with virtually no success.

The oxidation zone extends extraordinarily deeply in the Johann-georgenstadt mining district, so that, practically speaking, the oxidation products of bismuth, bismuth ocher, and others, represent the main ore below the silver zone. Only now and then do small grains of bismuth occur in the bismuth ocher. Vein apophyses, not engulfed like others by these relatively recent pervasions (Durchbewegungen) at the great vein fissures, still bear primary ores in the depths at which only secondary ores are to be encountered in the main vein.

This heavy pervasion of the deposited bismuth ores ^{caused} ~~by~~ the vein filling material, which was already variable (absätzig) in the primary deposits, to be crushed and displaced very extensively at the main veins. For this reason, on the other hand, there is the possibility in the Johanngeorgenstadt area (which so far, from the viewpoint of the geology of deposits, has been mined only to slight depths -- mining operations were conducted mostly at the crushed vein segments) that ore can still be found beneath these crushed vein segments, as is the case at Joachimsthal. At Joachimsthal, beneath a crushed zone about 200 meters thick, rich bismuth ores appear again at the main veins.

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B. Production:

Exact numerical data on the production of ore and its content for the earlier periods of operation are not available. The extent to which crude ore has been mined, the quantities of concentrate, and their content are known only for recent years.

The following survey gives these production figures from 1943 and 1944:

<u>Crude Ore Mined</u>			
<u>1943</u>	<u>1944</u>	<u>1943</u> <u>% Bi extractable</u>	<u>1944</u> <u>% Bi extractable</u>
2,238 tons	1,092 tons	0.10	0.70

The great increase in the bismuth content of the crude ore in 1944 may be accounted for by the intensified mining of the rich vein segments of the Himmelfahrt Section to compensate for the decreased production of bismuth arising from the partial flooding of the Schneeberg mine. The bismuth production of Johanngeorgenstadt from the calendar year of 1825 to the end of the ^{fiscal} ~~calendar~~ year of 1943 amounted, as shown on the following list, to 224,350 kilograms of bismuth.

With regard to the production of uranium ore, the following remarks may be made:

Available statistical surveys give only the uranium ore production in tons and sales proceeds. The sales proceeds per kilogram of ore display extremely great fluctuation from about 15.00 RM to 24 pfennigs. According to Krusch, in "The Investigation and Evaluation of Ore Deposits" (Die Untersuchung und Bewertung von Erzlagerstätten), 3rd edition, page 480, the price of uranium pitchblende ore a few decades ago, before the discovery of radium, remained practically constant. Krusch gives a table of price levels in Austrian crowns. This table indicates that the poorer ores were purchased at almost the same price as the richer ones. From the table, it is to be assumed that the price of 19.2 crowns fixed by Krusch for 60 percent concentrate coincided approximately with the highest price fixed for the Joachim-

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georgenstadt product during the last period of uranium mining. From this it was assumed that the sales product had a U_3O_8 content of 60 percent (Joachimgeorgenstadt production in 1892) and, on this basis, from the sales proceeds up to 1877, the presumed U_3O_8 content of the ore was determined. For the period from 1825 to 1876, the average U_3O_8 content of the ore was determined at 21 percent. This corresponds to the average content of the ores from Schneeberg and Johanngeorgenstadt, determined in the manner shown above, for the period from 1877 to 1894.

The uranium ore production of Johanngeorgenstadt is as follows:

<u>year</u>	<u>kilograms of ore</u>	<u>kilograms of U_3O_8</u>
1827 - 1873	18,580	3,900
1887	167	73.5
1889	215	74
1890	608	246
1891	465	210
1892	308	190
1893	130	47
1894	208	33
1895	104	28
1896	340	23
1905	2,745	280
1906	2,490	229
1907	853	25
1910	1,363	21
1911	700	6
1912	60	0.5
1913	112	5
1938	250	39
	<u>Total 29,698</u>	<u>6,086</u>

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C. Maximum Depths Hitherto Attained:

In the western part of the area, in the area of the Himmelfahrt on the Milchsachchen, mining has progressed to about 140 meters below the outcropping, corresponding to an altitude of 630 meters above sea-level. Probings have been made to 565 meters above sea-level, or 205 meters below the outcropping; they have shown the vein to be barren.

The Wilder Mann mine, approximately on the border between the outer and inner aureoles, has been mined to 110 meters below the outcropping, corresponding to an altitude above sea-level of 780 meters. Probes 15 meters below this level show the vein yet to be ore-bearing, with a bismuth content of 0.2-0.3 percent.

In the central portion of the Johanngeorgenstadt ore-region, near Adolphus, are the deepest shafts, approximately at the same level as the Gnade Gottes Stolln, about 714 meters above sea-level, or 134 meters below the outcropping.

In the vicinity of the Schaarschacht, mining operations have been conducted down to the 300 meter level, corresponding to 280 meters below the outcropping and an altitude of 535 meters above sea-level. Probes have been made down to 305 meters below the outcropping and to an elevation of 510 meters above sea-level, and they show that ore still runs down below the deepest mining level. The granite-schist boundary lies in this area at an altitude of 520-530 meters above sea-level.

The deepest mining operations at the Frisch Glück Section have taken place between the 78 and 93 lachter levels, to 200 meters below the outcropping, approximately 540-565 meters above sea-level. There the granite appears at a level about 530 meters above that of the sea.

If one compares these figures, it appears, particularly in the Wilder Mann and Adolphus areas, but also at the Vereinigt Feld in the Festenberge and at Frisch Glück, that the veins have been worked only to relatively slight depths. Particularly in the Wilder Mann and

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Adolphus areas there seem to be possibilities for mining at still lower levels.

D. Further Opportunities for Mining Operations:

As already mentioned in the last paragraph of C, there are further possibilities for mining operations, particularly between the Wilder Mann mine and the Hohneujahr Mgg. (?). The possible ore reserves in the accompanying table, for the most part, refer only to the veins in this zone.

signed Dr. Oelsner

Freiberg/Saxony, 4 October 1945

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COMPILATION OF THE DELIVERIES OF METAL FROM THE MINING SECTION"JOHANNGEORGENSTADT"

<u>Calendar Year</u>	<u>Average Annual Labor Force</u>	<u>Bismuth (kg)</u>
1825		46.000
1826		37.000
1827		25.000
1828		58.000
1829		135.000
1830		484.000
1831		193.000
1832		321.000
1833		533.000
1834		368.000
1835		740.000
1836		375.000
1837		312.000
1838		366.000
1839		665.000
1840		141.000
1841		418.000
1842		520.000
1843		155.000
1844		102.000
1845		58.000
1846		293.000
1847		385.000
1848		41.000
1849		252.000
1850		257.000
1851		57.000
1852		32.000
1853		---

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<u>Calendar Year</u>	<u>Average Annual Labor Force</u>	<u>Bismuth (kg)</u>
1854		15.000
1855		15.000
1856		255.000
1857		184.000
1858		266.000
1859		225.000
1860		170.000
1861		257.000
1862		354.000
1863		102.000
1864		67.000
1865		528.000
1866		480.000
1867	65	828.000
1868	62	369.000
1869	66	702.000
1870	62	858.000
1871	65	966.000
1872	61	783.000
1873	50	824.000
1874	26	507.000
1875	17	---
1876	20	485.000
1877	27	518.000
1878	27	495.000
1879	28	602.800
1880	29	816.000
1881	31	1,443.000
1882	43	2,045.000
1883	46	2,257.000
1884	56	2,012.000

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<u>Calendar Year</u>	<u>Average Annual Labor Force</u>	<u>Bismuth (kg)</u>
1884	56	2,012.000
1885	65	2,082.000
1886	71	1,890.000
1887	73	2,314.000
1888	66	1,465.000
1889	65	1,925.000
1890	65	2,057.000
1891	71	2,246.000= 2,236.000
1892	72	2,282.000
1893	72	1,541.000
1894	70	968.000
1895	40	846.000
1896	35	511.000
1897	34	382.000
1898	32	1,032.000
1899	32	1,228.000
1900	65	2,057.000
1901	37	1,448.000
1902	38	1,995.000
1903	42	2,613.000
1904	47	2,054.000
1905	41	2,431.000
1906	42	2,960.000
1907	42	3,018.000
1908	46	3,657.000
1909	45	3,048.000
1910	37	1,927.000
1911	39	2,554.000
1912	37	1,958.000
1913	35	2,324.000

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<u>Calendar Year</u>	<u>Average Annual Labor Force</u>	<u>Bismuth (kg)</u>
1914	34	2,628.000
1915	29	1,879.000
1916	30	1,453.000
1917	41	1,742.000
1918	42	1,826.000
1919	39	1,029.000
1920	39	725.000
1921	40	2,110.000
1922	42	2,436.000
1923	46	2,409.000
1924	46	3,916.000
1925	44	5,259.000
1926	50	5,754.000
1927	40	4,806.000
1928	35	7,212.000
1929	38	3,738.000
1930	18	4,271.000
1931	14	3,717.000
1932	8	2,977.000
1933	22	----
1934	35	----

110 calendar years 1825 - 1934	143,274.800
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Fiscal year 1935 (1 Apr 35 - 31 Mar 36)	37	1,880.050
Fiscal year 1936	47	5,254.995
" " 1937	63	14,672.314
" " 1938	71	9,692.711
" " 1939	76	13,376.205
" " 1940	74	13,309.315
" " 1941	67	8,304.958
" " 1942	67	7,454.583
" " 1943	76	7,091.065

9 fiscal years	81,075.196
Calendar year 1825 to fiscal year 1943	224,349.996

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Production of Concentrate

	<u>1943</u>	<u>1944</u>
Concentrate (tons)	291.94	394.23
Bismuth content (percent)	15.0	19.5
Bismuth content (tons)	*tr. 4.36	7.66
Bismuth content of the pure ores (tons)	<u>2.64</u>	<u>1.94</u>
Total production (tons)	7.00	9.60

* NOTE: Presumably this stands for the the German word
"troeken", meaning "dry".

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POSSIBLE ORE RESERVES OF THE EISMUTH ONE DEPOSITS OF THE ROMANOWSKO-GEORGISTADT

No.	Vein	Position	Coefficient of Mining Worth	Average Length (meters)	Average Dip (degrees)
1.	Kohnenjahr Hgg. West	Below the Gnade Gottes Stolln, 240 meters deep	0.25	400	80
2.	Segen Gottes Hgg.	Above the 26 lachter level, 250 meters	0.25	150	75
3.	Gustav Hgg.)	50 meters above and 100 meters below the 46 lachter level = 150 meters	0.25	250	80
4.	Daniel Spat)				
5.	Sam auf Gott Hgg.)				
6.	Erzengel Fläche	Eisenerz-Gnade Gottes Stolln, 65 m + 150 m thereunder = 215 meters	0.20	450	70
7.	Engelsfreude Hgg.	200 meters below the Liebe Gottes Stolln	0.20	250	75
8.	Johann Spat)	50 meters above and down to 200 meters below the Liebe Gottes Stolln = 250 meters	0.25	500	70
9.	Christen Spat)				
10.	Hilfhand Hoffnung Spat)				
11.	Brüderliche Treue Spat)				
12.	Himmelstürz Hgg.)				
13.	Bergmannsglück Hgg.)				
14.	Johannes Spat)				
15.	Blies Spat)				

Expected ore yield in the Johanneergeorgestadt Mining District per meter vertical depth

On that basis, the possible ore reserves down to an average vertical depth of 225 meters are:
 Furthermore, the visible and apparent deposits according to the 1944 plan of operations should yield:

45,000 tons of ore containing about
5,000 " " " " " "
50,000 " " " " " "

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MINING DISTRICT

Ore Incidence (t/ sq m)	Ore Incidence per vertical depth and tons/ sq meter	Average Ore Incubation according to depth t/m vert depth	Average Ore Incubation according to depth		
			kg P1	kg C0	kg P1
0.500	0.560	56	130	—	—
0.375	0.390	15	37.5	—	—
0.250	0.260	16.25	40.6	—	—
0.375	0.395	35.5	68.75	—	—
0.500	0.580	29	72.5	—	—
375 0.375	0.395	50	125	—	—
201.75			494.35		

1.10 tons of blamth
10 " " "
120 " " "

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III. BI-CO-NI MINING AT SCHNEEBERG, WITH PARTICULAR EMPHASIS ON

THE PRODUCTION OF URANIUM

A. Vein Conditions:

The Schneeberg cobalt field is situated at the northeastern edge of the Eibenstock granite massif, between the Eibenstock Granite and the Aue-Oberschlema Granite. There, in a depression in the surface of the granite -- the depression has a steep flank in the southwest and a rather level flank in the northeast -- there occur a number of long veins, some of which are several kilometers long, trending in a northwest-southeast direction. Northwest of the area there occurs a second system running in a NNW-SSE direction. These ore-bearing fissure systems are traversed by non-mineralized veins with a northeast-southwest trend.

To the northwest and southeast of this fissure area (a total of about 150 veins are known) there occur fissures, also trending in a northwest-southeast direction, which display pneumatolytic quartz-wolframite veins. These wolframite veins also bear bismuth, although in slight quantities.

Moreover, in the Schneeberg area, veins of the pneumatolytic tin formation and veins of high-thermal copper and lead are known; they are of no importance whatsoever.

The dip of the veins is variable, but in most cases to the northeast. The country rock of the veins, in the vicinity of the granite, is a contact-metamorphosed phyllite and, in the central portion of the vein area in the upper levels, it is unaltered phyllite. In mining operations granite has been encountered both in the northeastern and southwestern parts of the field. Mining is conducted in these areas both in the granite and ⁱⁿ its schistic mantle. There is no fundamental change in the veins during the transition from schist into granite. Individual veins become barren in the schist, while others frequently bear rich ore right into the granite. The thickness of the veins varies at the present time from cracks to over 1 meter; in the past, the thicknesses were even greater. One

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may differentiate between two types of vein:

1) Veins bearing predominantly quartz as gangue and characterized by a relatively low silver content and high bismuth and cobalt contents, and

2) Veins with barytic and carbonathic (?) (karbonatig) gangue, which are characterized by the metal combination nickel-silver and a reduced content of bismuth and cobalt.

The former group, the cobalt-bismuth group, has been the more important in the last century as far as mining is concerned. The veins of this type are also considerably more numerous than those of the second group. At the present time, only the veins of the former are being exploited. In the primary zone, their mineral content consists chiefly of bismuth in the natural state, smaltite, and minerals of the rammelsbergite-safflorite group, which, intimately intergrown, are called "heterogeneous cobalts" (Gemengkobalte) by the Schneeberg miner. In all cases, bismuth is the predominant metal.

In the zone of oxidation, the bismuth has been transformed entirely into bismuth ochre. The presence of sulphides and arsenides gives rise to the formation of extremely numerous minerals, some of which occur only in Schneeberg.

Despite the considerable emanation content in the Schneeberg area, uranium ores occur rarely and have, practically speaking, significance only from the mineralogical and deposit-geological viewpoints, even though there was a slight production of uranium ore in Schneeberg at the end of the last century.

Uranium ores occur both in the area of the old Daniel Stolln and the Siebensohlen Spat in the southwestern part of the cobalt field as well as in the area of the Weisser Hirsch and Fürstenvertrag mines in the northeastern part of the cobalt field. The Sauschwart mine in the central portion of the cobalt field also bears some pitchblende.

The uranium-pitch ores occur almost entirely as kidney-shaped pockets, embedded irregularly in the lode stuff. Large, clearly

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defined pockets appear to occur rarely. For this reason, the Schneeberg uranium ores display only a slight content. In one case, at the Katharina Flache, at the 140 lachter level, there is uranium-pitch ore impregnation of the granite subjacent to the vein. This is the only case known in the Schneeberg area where uranium-pitchblende occurs outside actual vein fissures. The country rock of the Schneeberg veins is otherwise free of uranium. Aside from the pockets of pitchblende, the Schneeberg crude ore contains no uranium. These pockets of pitchblende occur at the Katharina and Fürstenvertrag Flachen near the Weisser Hirsch mine and also at the Daniel Stolln and Siebenschlehen Spat in the vicinity of the granite boundary.

Uranium production in Schneeberg was first mentioned in 1825. Rather small quantities of uranium ore were mined from 1850 to 1854. In 1870, after a long interruption, the mining of uranium was again resumed and was pursued -- with interruptions -- from 1870 to 1905.

Altogether a total of 137 tons of uranium ore with an estimated uranium content of 8.7 tons (expressed as U_3O_8) (see below), corresponding to a content of 6.3 percent U_3O_8 , have been produced in Schneeberg.

B. Production:

Exact figures on the ore production and its U_3O_8 content from the early periods of operation are not available. The extent of the mining of crude ore, the quantities of concentrate, and the contents of the latter are known only for recent years.

The following survey gives these production figures for 1943 and 1944:

	<u>1943</u>	<u>1944</u>
oxydic concentrate (tons)	25.91	4.34
bismuth content (percent)	21.4	26.8
bismuth content (tons)	5.55	1.16
arsenidic concentrate (tons)	78.00	58.83
bismuth content (percent)	5.2	5.7
bismuth content (tons)	4.07	3.32
cobalt content (percent)	2.1	
nickel content (percent)	0.8	3.6
cobalt content (tons)	1.63	
nickel content (tons)	0.58	2.08

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According to the following table, the production from the calendar year 1867 to the end of the fiscal year 1943 was:

1,656,562.537 kilograms of bismuth,
485,444.810 kilograms of cobalt, and
287,524.895 kilograms of nickel.

These production figures, which were compiled by the mine, refer to the metal in the concentrate and pure ores delivered to and purchased by the smelteries.

With regard to the production of uranium ores, the following remarks may be made:

The available, statistical surveys give only the production of uranium ore in tons and the sales proceeds. The sales proceeds per kilogram mined display extremely great fluctuation between approximately 15.00 RM to 24 pfennigs. According to Krusch in his "The Investigation and Evaluation of Ore Deposits", 3rd edition, page 480, the price of uranium pitchblende in the last few decades, before the discovery of radium, remained approximately constant. Krusch gives a table of price levels in Austrian crowns. The table indicates that the poorer ores were purchased at almost the same rate as the richer ones. Moreover, it may be assumed from the table that the price of approximately 19.2 crowns fixed by Krusch for the 60 percent concentrate coincides about with the highest price for the Johanngeorgenstadt product during the last period of uranium mining. Therefore, a uranium content of 60 percent U_3O_8 is assumed for this product (Production of Johanngeorgenstadt in 1892) and on this basis, from the sales proceeds up to 1877, the presumed U_3O_8 content (by weight) has been calculated. For the period from 1825 to 1876, the average content of the ore has been figured at 21% U_3O_8 . This corresponds to the average percentage content of the ore from Schneeberg and Johanngeorgenstadt for the period from 1877 to 1894, which was determined in the manner given above.

The uranium ore production at Schneeberg is as follows:

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<u>Year</u>	<u>Kilograms of Ore</u>	<u>Kilograms of U₃O₈</u>
1825 - 1854	462	97
1870 - 1876	1,992	420
1877	94,000	904
1878	1,800	216
1879	2,361	201
1880	2,500	186
1881	3,656	428
1882	2,414	462
1883	1,630	540
1884	3,233	702
1885	4,080	830
1887	2,990	1,410
1888	2,060	605
1889	5,383	1,080
1890	4,535	345
1894	1,304	39.4
1896	5	1.5
1898	11	5.5
1900	590	18.5
1901	500	46.0
1905	1,467	110.0
1931	?	21.5
	<u>136,973</u>	<u>8,669</u>

C. Great depths heretofore attained:

In the southwesternmost part of the deposit region, at the Adam Heber Flache, mining operations have progressed only a slight distance below the Marx Semmler Stolln (180-200 meters). Further to the northwest, at the Wolfgang Maassen, Daniel Stolln, and Siebenschlehen Spat, mining operations and investigational probes have gone down to the 100 lachter level (300-400 meters below the surface of the ground).

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In the central portion, from Sauschwart to the Fürstenvertrag Flache, the 110 lachter level is the lowest at which mining operations are conducted at the present time and the 420 meter level is the lowest open lode (Aufschluss). In the central area near the Katharina Flache, the 140 lachter level (about 480 meters below the surface of the earth) is the deepest point worked. At the Georg Flache and Walpurgis Stollen a rich ore-shoot was traced down to the 155 lachter level, approximately 480-500 meters below the surface of the earth.

These depths reflect clearly the impoverization of the rich ore-shoots, conditioned by the nature of the deposit, at the various levels. So far as deposits are concerned, these various zones all rest on the same plane, namely, an isothermal surface, the form of which is greatly dependent on the cooling granite and its configuration.

There is, therefore, little likelihood of encountering any large deposits far down in the peripheral area in which mining operations still have not been conducted at great depths. In the central area, on the other hand, some veins continue to bear ore to a limited extent. Schneeberg mining operations in the future, therefore, even as in recent years, will have to be limited to the exploitation of the yet quite considerable vein remnants (Gangreste) left behind by the miners of yesteryear, aside from the investigation and exploitation of some veins in the central part. The appended table shows the ore reserves yet to be expected in Schneeberg.

D. Further Opportunities for Mining Operations:

1) Uranium ores:

As, in contrast to St. Joachimsthal and Johanngeorgenstadt, there are no pure uranium ore veins in the Schneeberg mining district -- the slight quantities of pitchblende discovered so far have been in the form of small pockets scattered throughout the individual veins -- there is no possibility of conducting investi-

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gative work on uranium. There is no hope of finding any appreciable quantity of uranium along with the mining of bismuth. The fact that the mine does bear uranium ore, as was mentioned by way of introduction, is to be regarded purely as a mineralogical and deposit-genetic anomaly; it can never provide the basis for mining production.

2) Bismuth:

In the table of the possible ore reserves, the location of promising parts of the individual veins is given. For this reason, reference is made to this survey concerning the possibilities of developing bismuth mining.

Freiberg/Saxony, 3 October 1945

OWO/Re1

signed Dr. Oelsner

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A Compilation of the Deliveries of Metal from the Schneeberg Section of the Saxon Ore Mining Corporation

<u>Calendar Year</u>	<u>Average Annual Labor Force</u>	<u>Bismuth (kg)</u>	<u>Cobalt (kg)</u>	<u>Nickel (kg)</u>
1867	690	11,992.250	13,389.370	8,294.800
1868	722	10,521.600	9,459.500	6,423.250
1869	786	16,766.080	10,212.580	7,166.750
1870	808	20,777.000	12,289.500	8,630.500
1871	789	25,782.750	9,113.000	6,491.750
1872	764	21,017.000	10,009.000	5,725.250
1873	727	20,091.500	10,429.000	5,523.000
1874	681	25,354.600	8,643.500	4,868.000
1875	632	26,502.500	6,147.250	4,393.500
1876	600	25,836.500	7,734.500	4,089.000
1877	584	28,201.700	9,017.090	4,485.525
1878	608	26,439.500	8,605.250	3,503.250
1879	607	29,246.500	8,005.750	3,560.500
1880	642	26,394.750	7,986.750	3,272.000
1881	658	29,312.750	9,226.750	4,122.250
1882	636	30,616.250	8,907.500	5,574.500
1883	632	29,834.750	9,302.500	6,264.750
1884	642	31,247.000	9,311.750	5,857.500
1885	653	28,706.250	8,355.250	5,763.750
1886	622	24,376.750	9,428.250	6,873.500
1887	656	28,663.000	10,324.650	6,849.900
1888	654	30,002.500	11,111.500	6,630.250
1889	660	23,565.750	11,492.500	5,566.950
1890	637	27,439.750	11,627.500	6,669.750
1891	640	26,438.000	10,818.550	6,268.400
1892	645	32,741.750	12,258.250	6,947.250

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Calendar Year	Average Annual Labor Force	Bismuth (kg)	Cobalt (kg)	Nickel (kg)
1893	647	35,908.250	10,494.800	6,807.050
1894	638	45,171.000	12,942.000	7,641.250
1895	607	42,436.500	17,547.500	9,896.250
1896	557	50,992.500	19,359.750	12,239.000
1897	493	46,969.500	13,321.500	8,733.000
1898	470	41,435.000	10,221.500	5,723.000
1899	460	40,097.900	10,364.650	5,728.950
1900	451	34,047.250	9,754.500	5,117.500
1901	468	28,402.750	9,408.750	4,835.250
1902	480	36,425.000	9,514.250	5,270.000
1903	468	32,067.750	7,892.750	3,879.250
1904	470	33,695.500	8,416.000	4,048.100
1905	434	28,126.250	6,458.000	4,500.000
1906	423	27,561.500	6,569.000	4,669.750
1907	348	25,375.250	5,447.250	4,585.750
1908	365	26,079.500	7,100.500	5,868.500
1909	320	29,867.750	5,685.500	4,807.250
1910	266	27,054.250	5,257.750	3,279.500
1911	238	22,347.000	3,586.750	2,225.000
1912	212	20,671.650	3,478.400	2,386.750
1913	216	15,573.750	4,421.250	3,107.750
1914	204	18,792.500	3,380.250	2,129.250
1915	176	17,927.750	3,120.500	1,708.500
1916	156	14,673.000	1,921.500	1,061.500
1917	200	15,772.250	2,440.250	1,404.000
1918	249	13,597.250	2,641.750	1,635.000
1919	212	11,298.500	1,960.750	825.250
1920	180	14,415.500	2,173.250	932.000
1921	156	15,253.750	2,415.250	1,471.250
1922	136	12,329.250	1,851.750	964,000

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Calendar Year	Average Annual Labor Force	Bismuth (kg)	Cobalt (kg)	Nickel (kg)
1923	94	8,145.000	1,583.750	837.000
1924	74	9,687.750	807.500	450.750
1925	55	8,871.750	607.250	527.500
1926	50	8,496.500	244.500	142.250
1927	46	8,944.500	42.000	31.000
1928	42	7,172.500	53.250	26.000
1929	35	3,017.000	--	--
1930	34	1,795.000	--	--
1931	27	3,036.000	--	--
1932	14	--	--	--
1933	21	--	--	--
1934	48	--	--	--
68 calendar years 1867 - 1934		1,543,400.280	465,692.840	279,409.925
Fiscal year 1935 4/1/35 - 3/31/36	35	1,958.295	--	--
Fiscal year 1936	35	5,598.440	--	--
" " 1937	89	15,938.885	2,530.120	1,687.730
" " 1938	88	18,428.515	3,974.350	1,854.970
" " 1939	72	9,068.560	3,749.840	1,692.680
" " 1940	120	15,419.950	3,169.170	1,160.050
" " 1941	124	21,101.410	2,733.290	735.840
" " 1942	188	18,352.957	2,929.600	729.200
" " 1943	240	7,295.245	665.600	254.500
9 fiscal years		113,162.257	19,751.970	8,114.970
Calendar year 1867 to fiscal year 1943		1,656,562.537	485,444.810	287,524.895

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POSSIBLE ORE RESERVES OF THE SCHNEIDER MINING DISTRICT

No	Vein	Surface worked	Coefficient of mining worth	Average length (meters)	Average dip (degrees)	Ore incidence in tons/sq meter	Ore incidence in tons/sq m with reference to vert. depth	Average anticipated ore yield according to depth			
								tons per meter vertical depth	kg	kg	kg
									Si	Co	Si
1	Walburga-Stollen Georg-Flache	Remnants and below 155 lachter level = 50 meters	0.45	120	80	0.625	0.65	35	122.5		
2	Katharina Flache	20 to 110 lachter level = 180 meters	0.2	200	75	0.75	0.785	31.5	63		
		Remnants below 110 to 140 lachter level + 40 m = 100 meters	0.25	100	70	0.500	0.575	14	28		
			0.3	300	80	0.875	0.880	79	198		
3	Sagen Gottes Spat	Marx Semler Stollen to 50 lachter level = 100 meters	0.25	150	70	0.625	0.650	41.25	82.5		
4	Rosenkranz Spat	50 lachter level to Marx Semler Stollen = 100 meters	0.25	100	75	0.500	0.580	14.5	29		
5	Ajt- und Jung Turk Flache, Bescherb Glück Flache	Below 1st Ges. Stollen to 110 lachter level = 170 meters	0.15	1200	70	0.750	0.790	142	284		
6	Katharina Flache near Turk	Below 1st Ges. Level to 110 lachter level = 170 meters	0.25	350	75	0.635	0.660	57.75	115.5		
7	Ursula Flache	80 to 110 lachter level, totalling 150 meters	0.3	150	70	0.500	0.585	26	52.5		
8	Fürstenvertrag Flache	50 to 110 lachter level = 150 meters	0.25	350	70	0.500	0.585	19	96		
9	Daniel Stollen Anna Spat	Below the 100 lachter level = 50 meters	0.25	500	80	0.625	0.630	78.75	157.5		
10	Jung-Necke Spat	24 to 110 lachter levels = 180 meters	0.2	600	70	0.875	0.890	106.8	213.6		
11	Sieghart-Flache	To 110 lachter level =	0.2								

totalling 150 meters									
8	Flirstenvertrag Flache	50 to 110 lachter level = 150 meters	0.25	350	70	0.500	0.585	19	98
9	Daniel Stolla Anna Spat	Below the 100 lachter level = 50 meters	0.25	500	80	0.625	0.630	78.75	157.5
10	Jung-Necke Spat	24 to 110 lachter levels = 180 meters	0.2	600	70	0.875	0.890	106.8	213.6
11	Siebenschlehen Spat	70 110 lachter level = 75 meters	0.2	200	70	0.900	0.985	23.4	46.8
12	Wolfgang Spat	150 meters above and 50 meters below the 146 lachter level = 200 meters	0.25	350	65	0.625	0.640	56	112
13	Friedrich August Spat	80 meters above and 50 meters below the 146 lachter level = 130 meters	0.3	450	70	0.900	0.985	79	158
14	Sidonien Spat	100 meters above and 50 meters below the 146 lachter level = 150 meters	0.25	290	65	0.625	0.640	40	80
15	Eva Spat	30 meters above and 120 meters below the Marx Semmler Stolla = 150 meters	0.25	150	60	0.625	0.670 0.640	25	50
16	Adam Weber Flache	30 meters above and 120 meters below the Marx Semmler Stolla = 150 meters	0.25	200	70	0.625	0.650	32.5	65
17	Alexander Spat	30 meters above and 120 meters below the Marx Semmler Stolla = 150 meters	0.25	500	70	0.750	0.790	98.75	197.5
18	Friedrichst Spat	50 meters above and 120 meters below the Marx Semmler Stolla = 170 meters	0.25	600	70	0.625	0.650	97.5	195
19 20 21	Samuschwart Heffung Gottes Spat Heukilke Flache	90-110 lachter levels = 45 meters; 50 meters below the 110 lachter level; remnants above the 90 lachter level; total, 150 meters	0.25	600	70	0.625	0.675	101.25	202.5

16	Adam Weber Flache	30 meters above and 120 meters below the Marx Semmler Stollen - 150 meters	0.25	200	70	0.625	0.650	32.5	65
17	Alexander 8 pat	30 meters above and 120 meters below the Marx Semmler Stollen - 150 meters	0.25	500	70	0.750	0.790	96.75	197.5
18	Friedrichst Spat	50 meters above and 120 meters below the Marx Semmler Stollen - 170 meters	0.25	600	70	0.625	0.650	97.5	195
19	Gamschwart	90-110 lachter levels	0.25	600	70	0.625	0.675	101.25	202.5
20	Raffung Gottes Spat	- 45 meters; 50 meters							
21	Kohlilke Flache	below the 110 lachter level; remnants above the 90 lachter level; total, 150 meters							
22	Gabriel Spat	Between the Marx Semmler Stollen and the 110 lachter level - approximately 150 m	0.25	500	75	0.500	0.580	72.5	145
23	Jacobs Spat								
24	Kalbe Spat								
25	Esversicht Spat								
26	Mihling Spat								
27	Zwickau Spat								
28	Michaelis Flache								

Expected ore yield per meter of vertical depth in the Schneeberg Mining District

1,323.20 2,699.40

Accordingly, the possible ore reserves at an average vertical depth of 120 meters = 158,000 tons of ore with approx. 320 tons Bi

Visible and apparent ore reserves in 1944

7,500 " " " " " 15 " "

Total Ore Reserves 165,500 " " " " " 335 " "

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IV. THE BISMUTH-URANIUM ORE DEPOSIT OF SCHÖNFICHT

Between the towns of Schönficht and Perlsberg in the Kaiserwald there appears a vein system or mineralized zone of disturbance several kilometers long. This zone of disturbance runs approximately parallel with the line of granite-shale contact. In the past, ²in ore is supposed to have been mined near the village of Perlsberg, in the topographically most ~~highly~~ and most southeasterly situated portion of the vein system. Numerous mine ~~dump~~-dumps, scattered over a wide area, give indication of intensive prospecting activity. Apophyses of the iron-manganese formation, which occasioned the rather inconsequential mining of ferrolith, appear at this vein system in the extreme northwest, to the west of the village of Schönficht. At the northwestern end of the central part, there occur bismuth ores in an 800-1,000 meter long zone; uranium ores occur at the southeastern end. Apparently during the 16th Century the northwestern end of this central portion of the deposit system was mined for silver. Numerous shaft sinks at the outcropping and several drifts, the Upper, Lower, and Middle Maria Hilf Drifts and the Anna Drift (which was struck from the valley of the Mühlbach and which runs diagonally to the vein system), bear testimony of this mining activity. No information is available on the quantity of metal produced during this period.

Pastor Pössel, who was extremely interested in mining, attempted at the beginning of the 19th Century to revitalize mining in the Schönficht area. Two mining companies became interested in pumping out the old drifts. The Middle Maria Hilf Drift and the Anna Drift were pumped dry by one mining company, and the Lössheit Drift, situated in the southeastern part of the central portion of the vein system, was pumped out by the other. A new drift, somewhat above the level of the Middle Maria Hilf Drift in the ~~southeastern~~ southeastern part

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of the bismuth-silver zone, was driven approximately diagonally to the deposit. These mining attempts were unsuccessful. Silver ores were not found; on the other hand, as Pastor Pössel noted in the church records, bismuth ores were encountered at the latter drift.

As uranium ore was found in the mine dumps of the Lössheit Drift, prospecting for uranium ores (autunite) was conducted in 1906; in that connection, the small Emilien Shaft was sunk from the ground surface to the floor of the drift. This Emilien Shaft followed torbernite-bearing apophyses and consequently is extremely irregular. The following picture of the deposit has been indicated by the results of prospecting work so far:

In the immediate vicinity of the granite-contact zone, where high-contact metamorphs -- crystalline schists permeated with numerous offshoots of the granite -- have been formed, there occur lodelike offshoot zones. The Lössheit Drift up to the Emilien Shaft displays alternately more or less thick apophyses of granite and interlying clods of schist. All the rocks are tectonically strained and display hydrothermal decomposition.

The veins discovered in the course of the work in the silver-bismuth area have not yet been encountered there. The entire rock complex is riddled with iron offshoots and rather thin fissures. A pronounced zone of disturbance, lying roughly along the trend of the vein system, has been traced south of the Emilien Shaft. Torbernite, autunite, and uranium ocher occur in this zone in the form of their decomposition products, impregnated into the fissures. Pitchblende has not been discovered thus far. Only rather old reports, designed to attract mining investors, deal at length with the possibility of discovering pitchblende at great depth.

According to available evidence, the irregularly scattered impregnations of torbernite in this thick zone may be incorporated

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into two main zones of impregnation. The first is to the south of of the Emilien Shaft, where there is a dikelike zone of autoclastic breccia consisting of lette and broken pieces of slate (Schieferbruchesteine). It trends approximately North 60° East and has a 90° dip. Its thickness at the drift is about 60 centimeters, diminishing as the upper investigatory levels driven from the Emilien Shaft are approached. Torbernite with some uranium ocher is said to occur frequently there in thick interstratifications between the individual fragments of rock; the country rock is also supposed to display occasional impregnation. In the thicker (about one centimeter) of the massive (derben) small offshoots, the torbernite and uranium ocher occasionally, microscopic indications of display a kidney-shaped structure, radially linked with a ~~radial~~ radial structure. Fine, concentric layers of torbernite and uranium ocher are said to alternate. According to Woldrich, this phenomenon does not give the impression that pitchblende has been transformed.

The second principal zone of impregnation appears 25 meters southeast of the Emilien Shaft, at the end of the Lössheit Drift, but trends almost perpendicularly to it ~~and~~ North 300° East and then curves to the south in the drift. Besides uranium ores, the zones of impregnation bear thin veins of quartz, which are older geologically than the uranium ores and which soon die out.

Assay samples taken in the period from 1906 to 1935 display uranium contents varying from 2-8 percent, in individual cases even up to 62 percent. No data on the samples were given, and, for that reason, they are of no value in evaluating the deposit. Undoubtedly, the average contents of these pocket-like impregnations are considerably lower, but because of the readiness with which torbernite lends itself to lixiviation, it would be economically feasible to work the deposit, despite the low content.

The occurrence of impregnated pockets in a thick offshoot zone, in which especially highly impregnated apophyses display great

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deviation in trend, as experience with autunite and torbernite ores elsewhere in the Erzgebirge has shown, ~~indicates the~~ ^{indicates the} probable lack of ore reserves of appreciable size.

There has been no rather recent prospecting in the bismuth area of this fault system. About 100 tons of pure bismuth ore with a content of approximately 2 percent Bi was extracted from old mine dumps during the first World War. Nothing is known about the quantities of other metals borne.

In 1938-39 an attempt was made to pump out the so-called Bismuth Shaft, the shaft from which these ores came. It turned out that it was an old shaft which ran down to a vein ^{apophysis} ~~apophysis~~ about 60-70 centimeters thick ~~and~~ running to the northeast. The fill in this shaft, however, displayed numerous chunks of pure bismuth ore. The three drifts at different levels gave rise to the presumption that the mining of silver had been profitable to some extent. If the bismuth ore had not been extracted along with the silver, then there ought to be a possibility of finding more bismuth ore in the gobbing in the exploited parts of the lode.

The plans for investigating ^{this} ~~the~~ portion of the deposit provided for the sinking of a shaft alongside the deposit and investigation at upper and lower levels.

A check of the existing mine dumps in 1944 showed that there were about 5,200 tons of culm ore containing 0.138 percent bismuth, corresponding to a metal content of approximately 7 tons. The erection of a small alkali lixiviation plant was planned in order to process the readily obtainable culm into bismuth oxychloride.

signed Dr. Oelsner

Freiberg/Saxony, 6 October 1945

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V. ST. VITI-ZECHE NEAR DÜRRMAUL

In the Dürrmaul area, in the Sandau-Marienbad-Planer Depression, there occur veins, possibly having their origin in the great apogysification caused in this block by the sinking. In the past, these veins were zealously mined for their copper ore. This mine is situated in the zone of contact metamorphism of the granite, which adjoins the Kaiserwald granite boss in the north across Marienbad. About one kilometer to the west of this mine runs the Glashütten "phalquarz" vein, trending in a north-south direction.

In 1919, the Bohemian Mining Corporation (Böhmische Montan-AG) of Dürrmaul sank an exploratory shaft in the St. Viti-Zeche area. Two large underground streams were struck; the water could not be held back because ~~much~~ solid matter in the water caused the pumps to wear out. An attempt was made in 1920-1923 to obtain a profile of the mining area by drilling out cores for the purpose of gaining information on the depth of the old shaft and the nature of the veins. Water was struck at a depth of 36 meters and it poured out the borehole at a rate of 100 liters per minute.

All told, the investigations resulted in the finding of seven of the old veins, which had been exploited to a depth of 110 meters. In 1924, at a distance of 30 meters to the east of the old shaft, a new shaft was sunk to a depth of 36 meters. The veins of the old workings were traced from the new shaft. As previously, there was a considerable flow of water. Not far from the shaft, in a prospecting trench, an offshoot bearing uranium pitchblende ore and running to the ground surface was discovered. There is no information on the quantity of uranium and radium extracted from that offshoot.

Rather large pockets of uranium pitchblende are said to have been discovered a short distance below the ground surface in the course of mining operations at other offshoots of the copper ore

veins exploited in the past. These were extracted and processed there as radium salts. Ores from Schönficht are also supposed to have been processed experimentally there.

The Joachimsthal Mining Corporation (Joachimsthaler Bergbau G.m.b.H.) conducted preliminary investigations there in 1943 by going around the countryside with a counter tube. Earlier investigations by Wienacker, Kohorn, and Löwe had established the sporadic occurrence of uranium pitch ore at side apophyses of the St. Viti-Zeche copper veins and the apparent presence of a radium ore deposit (determined with a counter tube), which could not be located by the sinking of a small shaft. The Joachimsthal Mining Corporation's investigations showed that there were strong radioactive indications at two other places.

Dr. Patschke, however, feels that the indications in these instances -- as was the case with the uranium pitch ore deposit sought by means of the short exploratory shaft -- were not caused by underlying ore, but, because the torbernite ores transported from Schönficht to St. Viti-Zeche in the early days ^{when} ~~and~~ radium sulphate ~~production~~ was produced there, radioactively infected the ground on which they were stored. Dr. Patschke is of the opinion that, in view of the extreme sensitivity of the counter tube, such an error in diagnosis could readily have been made.

Dr. Patschke does not consider the St. Viti-Zeche area particularly promising as far as radium ores are concerned. He attributes mostly mineralogical significance to the radium ores discovered there in the past, but does not believe that they ^{could} ~~support~~ an industry. On the other hand, he does think it would be well to investigate the ore veins for copper. The Joachimsthal Mining Corporation and the Radium Syndicate, as owners of the mine, therefore, are not going to prospect any further in this area in the near future.

The mine area is situated in the outer "water protection zone" of the Marienbad medicinal spring.

Freiberg, 6 Oct 1945

signed Dr. Oelsner

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VI. OTHER URANIUM ORE DEPOSITS

A. Freiberg

1) Himmelfahrt Mine were

Uranium ores ~~was~~ found there at vein junctions as a mineralogical rarity. Mining was not pursued on a regular basis. Only in 1909 were 260 kilograms of crude ore containing about 22 kilograms of U_3O_8 extracted.

2) Himmelsfürst Mine

Ore occurred in rather large quantities at the Himmelsfürst Mine, corresponding to the rather extensive occurrence of the precious dolomite formation (edle Braunsputformation), which bore the uranium pitch ores at Freiberg. Nodular uranium pitch ores were found from the Kalb Stehendes to the 7th Tool Level (Gezeugstrecke) in the vicinity of the August Flache. This ore was quite impure and was characterized by a tungstic acid content of 2.81 percent. Among the impurities were calcite, argentite, red silver ore, galena, and pyrites.

At the Komet Flache at the 1/2 11th [sic] Tool Level, earthy uranium ores, heavily contaminated with other minerals, were found. The high carbon content is worthy of notice. Analysis was as follows:

Sulphur	20.08 percent
Silver	1.91 "
Lead	0.85 "
Copper	6.50 "
U_3O_8	30.20 "
Iron	17.50 "
Calcium Oxide	1.01 "
Carbon	14.32 "
Hydrogen	0.98 "
Insoluble matter (mica, silica, etc)	4.80 "

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The production figures are:

<u>Year</u>	<u>Tons of Ore Mined</u>	<u>U₃O₈ Yield (kg)</u>
1887 - 1889	?	1,040
1894	0.430	180
1897	1.702	205
1900	0.740	47
1902	0.11	2

B. Annaberg

The Himmelsch Heer Mine near Annaberg and the Krönung Mine have produced only ^{5.1 kg of U₃O₈} ~~"Schauaufsteigen"~~ (2). Once the Himmelfahrt Mine near Annaberg sold 51 kilograms of ore containing approximately 7 kilograms of U₃O₈.

C. Marienberg

During the period 1870 - 1900, the Vater Abraham Mine produced 382 kilograms of ore, with a U₃O₈ content of approximately 73 kilograms, from the Bi-Co-Ni veins of Marienberg.

D. St. Christoph near Breitenbrunn

In 1905 and 1909, 333 kilograms of crude ore containing 39 kilograms of U₃O₈ were extracted from a vein of the Bi-Co-Ni formation cutting through the Margarethen Deposit of St. Christoph.

E. Himmelfahrt Mine and Krummetstook Boss near Gottesberg

In 1870 and 1874, 193 kilograms of crude ore of unknown U₃O₈ content (but estimated at 20 kilograms of U₃O₈) were mined. This ore came from a Bi-Co-Ni vein cutting through a greisen boss.

F. Magnetstolln, Zschorlau

In 1892, 50 kilograms of crude ore with an estimated U₃O₈ content of 16 kilograms ~~was~~ was mined there at a vein of the Bi-Co-Ni formation.

All told, approximately 1,651 kilograms of U₃O₈ were extracted from these mines; there is no possibility of mining any more ore.

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Besides ~~at~~ these mines, the production of which has been statistically established, uranium pitch ores were found at the Neu Unverhofft Glück Mine on the Luxbach near Oberwiesenthal, at the Alte Drei Brüder Mine in the Kiesholz near Wolkenstein, and, together with hematite, at an "E-vein" (Eisengang = iron vein ?) near Erla.

50X1-HUM

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